

# Viking Mission Support

D. J. Mudgway and A. I. Bryan  
DSN Systems Engineering Office

D. W. Johnston  
DSN Operations Office

*This article continues the report on the results of RF compatibility tests between Viking Orbiter No. 1 and the Spacecraft Compatibility/Monitor Station, Merritt Island, Florida (STDN-MIL 71).*

*It also includes the status of the Mission Configuration Tests (MCTs) and Operational Verification Tests (OVTs). The latter tests are complete, and all crews at all stations are trained for cruise support. Initial acquisition OVTs are scheduled to be run during July 1975 with the Deep Space Stations in Canberra, Australia.*

## I. Background

The previous article in this series described progress in Viking compatibility testing in January and February 1975. Activity has been continuing in this area and this article assesses the test results obtained through May 29, 1975. Also included is the status of the DSN testing and training culminating in the application of Viking configuration control on July 1, 1975.

## II. Viking Orbiter Radio Frequency Compatibility Tests

This assessment and status is derived from test results obtained between STDN(MIL 71) and Viking Orbiter No. 1 at Cape Canaveral, Florida, May 27-29, 1975.

Procedures for conducting these tests were prepared by the DSN with test parameters and design criteria related to Orbiter telecommunications performance. The final

procedures and test plans were approved during a meeting of the DSN/Viking Orbiter Telecommunications Representatives at Cape Canaveral, Florida. The total test time was 28 hours.

All tests in Ref. 1 were completed, although specified performance criteria for auxiliary oscillator No. 2 and low-rate telemetry were not actually met. The extent of completion of tests achieved within the scheduled time period was due in large measure to the excellent support provided by the JPL/Goddard STDN(MIL 71) and spacecraft teams.

### A. Test Objectives

The objective of the tests was to verify telecommunications compatibility between the DSN and Viking Orbiter No. 1. The test criteria and parameters simulated direct communications between an Orbiter flight article in Martian Orbit and a 64-m antenna station. Design

compatibility had been previously established between the DSN and Viking Orbiter No. 1 at the Compatibility Test Area in Pasadena, Calif. as reported in Ref. 2.

A selected set of standard tests were performed for verifying transponder, radio frequency (RF), command, telemetry, and radio metric compatibility. These tests were accomplished in accordance with the requirements of Ref. 1.

## B. Test Conditions

Viking Orbiter No. 1 was configured for mission operations and STDN(MIL 71) was configured to simulate a DSN 64-m antenna station. Viking Orbiter No. 1 was located in the clean room of Building AO, Cape Canaveral, Florida, and STDN(MIL 71) was located at Merritt Island, Florida. An S-band two-way RF link and an X-band one-way RF downlink were utilized between the flight article and the ground station. Both links were approximately seven miles.

S-band RF link variations were 0.5 dB peak-to-peak during the test. These conditions existed during daylight and evening hours on May 28 and 29, 1975. X-band RF link variations were 1.0 dB peak-to-peak during evening hours when critical X-band testing was being performed.

The ground station software utilized in performing these tests was supplied by the DSN and was a subset of software officially released to the station for Viking Project support. The programs consisted of:

(1) Telemetry and Command Program. This program provides independent control of the commanding and telemetry handling functions. Commands may be controlled manually from the station or automatically from the Mission Control and Computing Center, in Pasadena, Calif. Telemetry may be decoded, formatted, and transmitted to the Mission Control and Computing Center for decommutation and display.

(2) Planetary Ranging Assembly Program. This program provides either continuous spectrum or discrete spectrum operation for determining very accurate range estimates of a spacecraft at planetary distances.

## C. Test Results

The following radio frequency acquisition and tracking tests were performed:

- (1) Downlink threshold one-way

- (2) Uplink threshold
- (3) Downlink threshold two-way
- (4) Spacecraft receiver pull-in range and rate
- (5) Carrier residual phase jitter
- (6) Transponder rest frequency
- (7) Auxiliary oscillator frequency

The following problems were encountered:

(1) Auxiliary oscillator No. 2 was found to be approximately 800 Hz below design center frequency. Additionally, the one-way residual carrier phase jitter on auxiliary oscillator No. 2 was greater than specified performance. Although these conditions have been identified, it is felt that neither is significant enough to impact a successful mission. No retest is necessary.

(2) Two-way carrier phase jitter measurements were performed with uplink signal levels of -110 dBm and -108 dBm, respectively. MIL 71 uplink power level during these tests was adjusted for maximum spacecraft signal level.

A test of command capability under doppler conditions was conducted. No problems were encountered.

The following radio-metric data tests were performed:

- (1) Ranging channel delay threshold and polarity verification (S-band, single channel).
- (2) Ranging channel delay threshold and polarity verification (X-band, single channel).
- (3) Ranging channel delay threshold and polarity verification (simultaneous S/X-band)

While no problems were encountered, there was one condition which surprised the observers and the spacecraft test team: During the initial acquisition process of the ranging system, uplink modulation is removed for approximately one second. The effect is a transitory increase in spacecraft receiver automatic gain control. Initial investigation has verified that the ranging system software does, in fact, operate in this fashion. While there is no obvious harmful effect caused by this transient, it is not desirable, either. At the very least, it will be reported as a spacecraft idiosyncrasy. From the spacecraft telecommunications viewpoint, however, the software should be modified.

All objectives of these tests were met, including simultaneous S/X ranging which was accomplished for the

first time between the DSN and a flight spacecraft. Simultaneous delay measurements were within 3 ns of previously measured individual delay measurements. S-band link amplitude stability performance during this test was 1 dB peak-to-peak, and X-band was 2 dB peak-to-peak.

The following telemetry tests were performed:

- (1) Modulation index and spectrum analysis
- (2) Telemetry performance test

The following problems were encountered: In Test 14A (spacecraft radio mode 305), the low-rate data (8.3 bits/s uncoded) signal-to-noise ratio performance was below specified criteria. A postcompatibility test at MIL 71 to investigate this condition revealed that the low-rate telemetry channel performance was degraded by approximately 1 dB. A realignment of the system resulted in restoring proper performance of the low rate telemetry channel. It is safe to assume that the excessive loss in the station equipment was present during the compatibility test and accounted for the measurement falling outside its predicted range. It would be desirable, but not mandatory, to repeat Test 14A with the spacecraft if time and schedules permit.

### III. DSN Test and Training Preparations

A significant change from earlier planning was the decision to implement the second 26-m subnet (DSSs 12, 44, 62) prior to the first Viking launch. The majority of the Mission configuration tests for these stations have been performed, and the operational verification tests have just been completed.

Table 1 shows the current mission configuration test status of the 64-m, primary 26-m and secondary 26-m subnets, indicating actual testing status as of July 1, 1975.

The 64-m and prime 26-m subnets are considered trained to support Viking cruise operations. During the period of this report, DSSs 43 and 63 have completed cruise phase operational verification tests. DSS 14 and the prime and secondary 26-m nets have completed cruise and planetary operational verification tests. The stations have also supported Viking System Integration Tests, ground data system tests and various others of the project-related test series including flight operations personnel test and training. No problems are anticipated on future support of the latter tests. Stations 43 and 63 will be supporting planetary phase operational verification tests after launch and prior to encounter.

### IV. Conclusion

The planned sequence, number and duration of the Mission configuration and operational verification tests was adhered to with only minor exceptions.

The operational verification test program is now complete and all stations and the DSN Operations Control Team have achieved the desired level of Viking mission-dependent training proficiency required for Viking cruise support. The Mission configuration test program should be complete prior to launch.

Initial Acquisition OVTs have been scheduled for DSSs 42 and 44 in July to exercise the initial acquisition strategy produced by the DSN and concurred by the Viking Project. These are the final tests to verify launch and cruise readiness.

Configuration control for Viking was applied at all stations on July 1, 1975.

### References

1. Rev. J, *Master Integrated Test Plan Viking 75 Spacecraft/ Orbiter/Lander to Launch and Flight Operations System and Tracking and Data System Compatibility Test Plan*, NASA Document PL-3710005, March 29, 1972.
2. *The Deep Space Network Progress Report 42-24*, September and October 1974, pp. 9-13, Jet Propulsion Laboratory, Pasadena, Calif., Dec. 15, 1974.

**Table 1. Completion status of MCTs**

Stations	DSS	Systems			
		Telemetry	Command	Tracking	Monitor and control
64 m	14	C/P	4 h outstanding (dual exciter switch)	Not complete	C/P
	43	Cruise strong signal only	C	Not complete	C
	63	C	C	Not complete	C
Prime 26 m	11	C	C	Not complete	C/P
	42	C	C	Not complete	C/P
	61	C	C	Not complete	C/P
Secondary 26 m	12	C	C	RF portion only	C/P
	44	C	C	RF portion only	C/P
	62	C	C	RF portion only	C/P
C = cruise P = planetary					